BIODIVERSITY ATTRIBUTES OF AN ISOLATED WOODLAND FRAGMENT IN METROPOLITAN PERTH, WESTERN AUSTRALIA

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ABSTRACT

The macroscopic biological diversity of a small (<1ha), isolated bushland remnant at the edge of suburban Perth comprises over 130 species. Most taxa are invertebrates or vascular plants, whereas terrestrial vertebrates make a minor contribution to species richness. Intensive survey of this small fragment ensured that the flora and fauna were satisfactorily described, however, additional species are certain to exist and would be recorded by further scrutiny. The conservation 'value' of remnants is such that all areas of bushland remaining on the Swan Coastal Plain should be protected to preserve biodiversity values. It is suggested that biological survey procedures as currently practiced in the state of Western Australia do not adequately document biological diversity.

INTRODUCTION

The south-west of Western Australia is a global biodiversity 'hotspot' (Myers *et al.* 2000), to which the Swan Coastal Plain makes a major contribution. Although the term biological diversity, or its shortened form 'biodiversity', is frequently used as a descriptor for a range of situations, it is seldom clearly defined. The simplest and therefore most widely-used measure of biodiversity is species richness: the number of individual taxa occupying a specified area. Clearly, in general and on average, the larger an area, the greater will be its diversity (Arrhenius 1921; MacArthur and Wilson 1963).

As a consequence of the species-area relationship, it is especially difficult to fully document the biodiversity of large survey areas. Although the cumulative number of species recorded will be greater, many species will remain undetected due to their low density (particularly rare

species), secretive habits, inactivity (seasonal or diurnal), or senescence. The longer and more detailed a survey, the greater the variety of sampling methods, and the finer the resolution of fauna habitats or vegetation communities recognised, the more representative it will be in terms of characterising the biota of a study area, and therefore a region, or a biological zone (see Elton (1946), for a discussion of the validity of survey data). Two principal components, intensity and duration, will ultimately determine the comprehensiveness of a survey. The experience of the observers and their familiarity with the biota of the region will also influence survey outcomes.

Fragmentation and ultimately isolation of bushland areas in urban and agricultural settings is of widespread occurrence in southern and eastern Australia (Breckwoldt 1986). Loss of habitat has a negative influence on biodiversity, i.e. the number of animals and plants in an area will decrease over time (e.g. Commonwealth of Australia 1995; Jellinek *et al.* 2004; Bennett 1990 and references therein; Grimbacher *et al.* 2006). The precise alterations to species diversity and composition will depend on the history and nature of environmental modification. The biodiversity reduction response will be acute for areas that are heavily damaged, particularly where land-forming removes all vegetation, and only moderate for areas on the urban fringe, in which condition gradually deteriorates over time as a result of weed infestation and anthropogenic use and incursion. There are a variety of causes (e.g. introduced predators, fire, drought) for localised extinction. However, any factor that reduces population size will have a greater potential to affect long-term viability and ultimately extirpation due to stochastic (chance) fluctuations or accidental loss if the population is small and isolated. Urban environments are a major environmental concern because entire landscapes are completely destroyed or otherwise irretrievably altered when incorporated into an urban framework (see Garden *et al.*, 2006).

The urban arc of the expanding Perth megalopolis extends from the seaward fringe of the northern suburbs, north and south of the river, past Mandurah and down to Bunbury. With the exception of localised areas near Pinjarra and Yanchep, almost the entirety of the Swan Coastal Plain has been cleared for urban, suburban and peripheral expansion. A series of studies have examined the landscapes (e.g. Semeniuk 1988; Semeniuk and Glassford 1989; Seddon 1972 and references therein), components of vertebrate fauna (Cooper 1995; Davidge 1979; How and Dell 1990; Maryan 1984; Maryan *et al.* 2002; Mawson and Massam 1995;

Recher and Serventy 1991; Turpin 1990, 1991), vegetation (Beard 1979) and floristics (Cresswell and Bridgewater 1985; Keighery and Keighery 1993; Gibson *et al.* 1994) including weeds (Keighery 1998) of bushland on the Swan Coastal Plain near Perth. There is also an ever increasing quantity of unpublished material on urban bushland remnants, and a range of information, of variable quality, in consultant reports. Much of this information has been summarised in short form in the BushPlan (Department of Environmental Protection 1998) and subsequent Bush Forever documents (Government of Western Australia 2000). These studies show that while native mammals are highly susceptible to localised extinction in urban remnants, components, at least, of various animal groups may persist. Floristic diversity may also remain high, and remnants may support rare plant species and communities (Kirkpatrick 1986; Gibson *et al.* 2000). This paper reports on the biota of an isolated patch of *Banksia*-dominated woodland in southern metropolitan Perth, and provides an example of the importance of remnants for preserving biodiversity in the face of habitat loss due to continued urban development.

METHODS

Cocos Reserve (32°06'33"S 115°49'18"E) is situated in the suburb of Bibra Lake, City of Cockburn. It is less than one hectare in size, and is sandwiched between extensive cleared areas on all sides; to the south by a sandy track and railway, to the north by a large expanse of bare sand, and to the east by a wide sandy area adjacent to a major road. The area lies on siliceous white-grey Bassendean sands and there is only minor soil (humic) development. There is low to moderate leaf-litter accumulation, particularly around the dominant trees that form the overstorey; *Eucalyptus marginata*, *Allocasuarina fraseriana* and *Banksia attenuata*. The midstorey is moderately well developed and the site had remained unburnt for several years. Principal weeds are scattered Geranium *Pelargonium capitatum* and Veldt Grass *Ehrharta calycina* along edges.

Assessment of the flora and fauna was made by trapping and observation. Throughout January and into the first half of February 2003, pit-trapping was undertaken on most nights with four large buckets (30cm deep) with a 4m drift fence, and five small plastic containers (10cm deep). The number and types of animals captured were noted for each trap on each day. Elliott traps were tried initially but produced only the House Mouse *Mus musculus*. I recorded birds by aural and visual means; the species and the number of individuals were noted on each occasion. Botanical survey was carried out twice intensively and

also incidentally during and after trapping visits. A species recognition, or 'morphospecies' approach was used to classify the majority of invertebrate taxa.

RESULTS

A rich community of animal and plant species was recorded from Cocos Reserve (Table 1). The major contribution to faunal diversity was from the invertebrate community, including at least 70 species from 14 taxonomic groups (Table 1). This is not a complete list as new species of invertebrates were recorded on each trapping day. Many of the insects, spiders and acarines were abundant at the site.

Vertebrate animals included a single species of frog, several reptiles, predominantly skinks, and a small but apparently viable group of sedentary and roaming birds (Table 1, Appendix 1). Seven additional bird species were observed passing over the site; these waterbirds were not included as they are exclusive to habitats at nearby Little Rush

Table 1. Biodiversity attributes table for Cocos Reserve.

Taxon	Richness	Comments
Lizards (Reptilia: Squamata)	5 species	predominantly skinks
Frogs (Amphibia: Anura)	1 species	moving between wetlands ?
Birds (Aves) – native taxa	13 species	some resident individuals additional birds pass over
Spiders (Arachnida: Araneae)	15+ species	
Mites (Arachnida: Acarina)	2 species	small ground-dwelling species
Scorpions (Arachnida: Scorpiones)	1 species	
Beetles (Insecta: Coleoptera)	8 species	
Grasshoppers and crickets (Insecta: Orthoptera)	8 species	
Bees, ants and wasps (Insecta: Hymenoptera)	20+ species	over half the species are ants
Termites (Insecta: Isoptera)	2 species	observed not trapped
Bugs (Insecta: Hemiptera)	6 species	includes two cicada species
Cockroaches (Insecta: Blattodea)	2 species	
Flies (Insecta: Diptera)	3 species	including House Fly
Silverfish (Insecta: Thysanura)	2 species	
Earwigs (Insecta: Dermaptera)	1 species	
Mantids (Insecta: Mantodea)	1 species	
Centipedes (Myriapoda: Chilopoda)	2 species	both species trapped
Slaters (Crustacea: Isopoda)	1 species	? introduced species
Monocotyledons (Liliopsida) – native taxa	18 species	additional sedges present
Dicotyledons (Magnoliopsida) – native taxa	32 species	mistletoe present ?

Lake and other Beeliar wetlands. No nocturnal birds were observed, and the only mammals were non-native species (Appendix 1).

To date 50 species of native vascular plants have been identified at the site (Table 1, Appendix 2) and others were recorded. Strata components include six trees, 17 varieties of shrubs, and the majority of the plant diversity in the understorey layer, particularly amongst the herbs and sedges (Appendix 2). More than 16 exotic (introduced) plant species occur – mainly herbs and grasses; additional species would flourish in winter.

DISCUSSION

The persistence of a diverse community of animal and plant species at Cocos Reserve is exceptional given the small size of the reserve (< 1 ha), particularly as the site is completely isolated from adjacent bushland. The major contribution to biodiversity (~80% of fauna taxa) is due to the invertebrate community. Harvey *et al.* (1997) also documented a rich assemblage of invertebrates at urban bushland remnants near Perth, including many spiders and Baeine wasps. That the majority of diversity is amongst the invertebrates is not unexpected, because globally there are vastly more invertebrates than vertebrates (Barnes, 1980; Wilson, 1987). This suggests that in order to fully evaluate the biodiversity of a study area, survey objectives should include assessment of invertebrates. We can only begin estimating the relative value of diversity if we enhance the ecological information that is obtained.

Plants and animals (particularly vertebrates) are the most familiar types of organisms and the easiest to identify accurately, hence the level of expertise and state of knowledge is far superior to that for other groups. They are consequently the focus of the majority of biological surveys; our principle source of data for estimating biodiversity. They are assessed in preference to micro-organisms, fungi, invertebrate animals, or non-vascular plants. The vertebrate fauna and vascular plants of the Swan Coastal Plain and vicinity have been capably described and annotated (e.g. How 1998; Storr and Johnstone 1988; Marchant *et al.* 1987), and in some cases, analysed (How and Dell 1994, 2000). Although there have been some surveys of terrestrial environments that have examined specific invertebrate groups (e.g. Andersen 1986; Rossbach and Majer 1983; Gwynne *et al.* 1988), comprehensive surveys of invertebrate diversity are rare.

Vertebrates are used as the main faunal indicators of environmental health for environmental impact assessment, but it is frequently the absence of rare species, rather than the presence of a diverse community, that tips the balance in favour of

development. The comparative 'value' of bushland remnants is therefore determined on the basis of few taxonomic groups, and may in some cases be strongly, and somewhat subjectively influenced by the existence of populations of a single species. Reduced vertebrate diversity (particularly of prominent taxa such as mammals) in remnants due to isolation may not correspond to overall faunal diversity. Indeed, if we extrapolate biodiversity attributes of the better known faunal groups to the invertebrates, we would anticipate that many species of insects and arachnids are likely to be restricted to the Swan Coastal Plain and, by extension, to specific habitats within the landscape mosaic. If any legitimate attempts are to be made to retain biodiversity, then we have an obligation to examine other components of the biota in greater detail, refine methods of investigation and analysis to establish criteria and guidelines for preservation of biodiversity values, determine the full range of taxa that exist, and investigate ecological relationships more thoroughly.

Considering the small size of the Cocos Reserve remnant, it supports a diverse array of plant taxa. Over 50 native species have been recorded and more are likely to occur, particularly additional sedges, low shrubs, herbs (including orchids), mistletoes and weeds. Species-area curve extrapolations for plants based on the number of species recorded at Cocos Reserve and using data for several other comprehensively surveyed but relatively homogeneous sites on the Swan Coastal Plain (Shenton Park bushland and Talbot Road bushland), indicates an approximate relationship of the form $S = 45A^{0.415}$ where S is plant species richness and A is area in hectares. Sites such as the Brixton Street wetlands (Keighery and Keighery 1993) with multiple habitats and a complex array of understorey species, greatly exceed this average expectation based on area alone. This index is more appropriate for surveys of a single vegetation type such as *Banksia* woodland or Eucalypt forest, but requires comprehensive, detailed floristic information to be a useful and potentially meaningful measure. Flora surveys often focus on vegetation communities rather than floristic composition *per se* (although composition may be used to delineate communities), and assessment of representation is usually made on this basis, as is the case for the Perth region (Government of Western Australia 2000). The analysis presented here, although highly simplistic in its current form, suggests an alternative or complementary method for evaluating sites that is specifically relevant to interpretations based on biodiversity.

Limitations of the current survey are primarily in relation to duration, in that the data for

fauna were collected over a five week period (longer than most fauna assessment surveys), and in timing, because although summer is an appropriate time to survey reptiles (How 1998) and many insects, it may be less suitable for other fauna. Most floristic work was carried out in summer, so while the list is comprehensive for that season, it is possible that plants without remnant dry season structures could have been missed. Additional fauna species would be recorded during trapping in other seasons, and certain species are not amenable to capture by trapping, hence further opportunistic searches would contribute to a more comprehensive evaluation. The comparatively small size of the study area facilitated complete bird surveys on each occasion based on observation and call identification, but migrant or nomadic species may use the area in other seasons. The reptile list is likely to be adequate but incomplete because species accumulation through trapping may take many years (How 1998). Familial composition is however similar to other herpetofaunal surveys (e.g. Davidge 1979; How and Dell 1994; Maryan *et al.* 2002) in that the majority of species were skinks. The presence of the Moaning Frog *Heleioporus eyrei* in summer was unusual as there was no rain at the time. Other frog species may move through the area from local wetlands during the winter months, although they would have to traverse areas of bare soil with no shelter. Invertebrates appeared to be relatively active at the time of trapping, but I am not aware of any studies that give a clear indication of the most appropriate time (or times) to collect invertebrates in the south-west of Western Australia.

Bushland remnants often support a range of fauna species (How and Dell 1994; Kitchener and How 1982; this study) and vegetation communities (e.g. Keighery and Keighery 1993), and have value as habitat (Hodgson *et al.* 2006) even when of small size (Jellinek *et al.* 2004). However, in urban areas these sites are so sparsely distributed that effective and comprehensive retention of all biological attributes is no longer a feasible objective. The emphasis must instead be placed on the retention and persistence of as great a variety of ecosystem components as possible. Given the rapid rate of attrition of bushland in the Perth region, the only reasonable conclusion seems to be, that in order to maintain biodiversity (including all its components), *any* remaining areas of bushland in urban and suburban areas must be retained, and areas on the expanding fringe should be protected from degradation and loss. Proposals to delete portions of the landscape and their biological components need to be examined very closely, particularly, strategically and

specifically in areas of urban expansion where so few examples of diverse bushland remain, and in a region where there are numerous endemic taxa (Hopper 1979; Keighery 1996; Beard *et al.* 2000). The choices that are made now will determine the future of biodiversity in the region.

In order to fully appreciate the biodiversity attributes of a bushland area, we need to take a fine-scale local viewpoint, but a regional perspective. These two aspects are not always compatible, and it is not until the level of knowledge becomes adequate that rational decisions can be made about biodiversity conservation within the context of representative reservation. The Swan Coastal Plain is a special case in that it is the focus of urban expansion, but it has also been the focus of detailed biological study. However, even in this instance where there is an acceptable level of understanding of biodiversity components, there is an inadequate basis for approaching bushland conservation that is specifically relevant to biotic significance. In order for a rational system to be designed that has sufficient cohesion to ensure that it is culturally and politically persuasive, there is a requirement for a strategic and systematic approach that has explicit goals. This system must have the capability to incorporate the findings of biological surveys and utilise the information obtained to inform relevant and reasonable management decisions, including selection and allocation of areas with the sole objective of nature conservation.

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REFERENCES

ANDERSEN, A.N. 1986. Diversity, seasonality and community organization of ants at adjacent heath and woodland sites in south-eastern Australia. *Australian Journal of Zoology* 34: 53–64.

ARRHENIUS, O. 1921. Species and area. *The Journal of Ecology* 9: 95–99.

BARNES, R.D. 1980. *Invertebrate Zoology*. Saunders College, Philadelphia.

BEARD, J.S. 1979. *Vegetation Survey of Western Australia. The Vegetation of the Perth Area, Western Australia.* Map and explanatory memoir, 1 : 250 000 series. Vegmap Publications, Perth.

BEARD, J.S., CHAPMAN, A.R. and GIOIA, P. 2000. Species richness and endemism in the Western Australian flora. *Journal of Biogeography* 27: 1257–1268.

BENNETT, A.F. 1990. *Habitat Corridors: Their Role in Wildlife Management and Conservation.* Department of Conservation and Environment, Melbourne.

BRECKWOLDT, R. 1986. *The Last Stand. Managing Australia's Remnant Forests and Woodlands.* Australian Government Publishing Service, Canberra.

COMMONWEALTH OF AUSTRALIA. 1995. *Native Vegetation Clearance, Habitat Loss and Biodiversity Decline.* Biodiversity Unit Paper No. 6. Canberra.

COOPER, N.K. 1995. Vertebrate fauna of an isolated bushland reserve (No. 18325) in inner Perth. *The Western Australian Naturalist* **20:** 21–28.

CRESSWELL, I.D. and BRIDGEWATER, P.B. 1985. Dune vegetation of the Swan Coastal Plain, Western Australia. *Journal of the Royal Society of Western Australia* **67:** 137–148

DAVIDGE, C. 1979. A census of a community of small terrestrial vertebrates. *Australian Journal of Ecology* **4:** 165–70.

DEPARTMENT OF ENVIRONMENTAL PROTECTION. 1998. *Perth's Bushplan.* Department of Environmental Protection, Perth.

ELTON, C. 1946. Competition and the structure of ecological communities. *Journal of Animal Ecology* **15:** 54–68.

GARDEN, J., MCALPINE, C., PETERSON, A., JONES, D. and POSSINGHAM, H. 2006. Review of the ecology of Australian urban fauna: a focus on spatially explicit processes. *Austral Ecology* **31:** 126–148.

GIBSON, N., KEIGHERY, B.J., KEIGHERY, G.J., BURBIDGE, A.H. and LYONS, M. 1994. *A Floristic Survey of the Southern Swan Coastal Plain.* Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia, Perth.

GIBSON, N., KEIGHERY, G., and KEIGHERY, B. 2000. Threatened plant communities of Western Australia. 1. The ironstone communities of the Swan and Scott Coastal Plains. *Journal of the Royal Society of Western Australia* **83:** 1–11.

GOVERNMENT of WESTERN AUSTRALIA. 2000. *Bush Forever Volume 2 – Directory of Bush Forever Sites.* Government of Western Australia, Perth.

GRIMBACHER, P.S., CATTERALL, C.P. and KITCHING, R.L. 2006. Beetle species' responses suggest that microclimate mediates fragmentation effects in tropical Australian rainforest. *Austral Ecology* **31:** 458–470.

GWYNNE, D.T., YEOH, P. and SCHATRAL, A. 1988. The singing insects of King's Park and Perth gardens. *The Western Australian Naturalist* **17:** 25–71.

HARVEY, M.S., WALDOCK, J.M., HOW, R.A., DELL, J. and KOSTAS, E. 1997. Biodiversity and biogeographic relationships of selected invertebrates from urban bushland remnants, Perth,

Western Australia. *Memoirs of the Museum of Victoria* 56: 275–280.

HODGSON, P., FRENCH, K. and MAJOR, R.E. 2006. Comparison of foraging behavior of small, urban-sensitive insectivores in continuous woodland and woodland remnants in a suburban landscape. *Wildlife Research* 33: 591–603.

HOPPER, S.D. 1979. Biogeographical aspects of speciation in the southwest Australian flora. *Annual Review of Ecology and Systematics* 10: 399–422.

HOW, R.A. 1998. Long-term sampling of a herpetofaunal assemblage on an isolated urban bushland remnant, Bold Park, Perth. *Journal of the Royal Society of Western Australia* 81: 143–148.

HOW, R.A. and DELL, J. 1990. Vertebrate fauna of Bold Park, Perth. *The Western Australian Naturalist* 18: 122–131.

HOW, R.A. and DELL, J. 1994. The zoogeographic significance of urban bushland remnants to reptiles in the Perth region, Western Australia. *Pacific Conservation Biology* 1: 132–140.

HOW, R. and DELL, J. 2000. Ground vertebrate fauna of Perth's vegetation remnants: impact of 170 years of urbanization. *Pacific Conservation Biology* 6: 198–217.

JELLINEK, S., DRISCOLL, D.A. and KIRKPATRICK, J.B. 2004. Environmental and vegetation variables have a greater influence than habitat fragmentation in structuring lizard communities in remnant urban bushland. *Austral Ecology* 29: 294–304.

KEIGHERY, G.J. 1996. Phytogeography, biology and conservation of Western Australian Epacridaceae. *Annals of Botany* 77: 347–355.

KEIGHERY, G. 1998. The weeds of Garden Island – an annotated list. *The Western Australian Naturalist* 22: 61–76.

KEIGHERY, G.J. and KEIGHERY, B.J. 1993. *Floristics of Reserves and Bushland Areas of the Perth Region (System 6). Parts V–IX.* Wildflower Society of Western Australia (Inc.), Perth.

KIRKPATRICK, J.B. 1986. The viability of bush in cities – ten years of change in an urban grassy woodland. *Australian Journal of Botany* 34: 691–708.

KITCHENER, D.J and HOW, R.A. 1982. Lizard species in small mainland habitat isolates and islands off south-western Western Australia. *Australian Wildlife Research* 9: 357–363.

MACARTHUR, R.H. and WILSON, E.O. 1963. An equilibrium theory of insular zoogeography. *Evolution* 17: 373–387.

MARCHANT, N.G., WHEELER, J.R., RYE, B.L., BENNETT, E.M., LANDER, N.S. and MACFARLANE, T.D. 1987. *Flora of the Perth Region.* Western Australian Herbarium, Perth.

MARYAN, B. 1984. Herpetofauna of an urban area near Perth, Western Australia. *The Western Australian Naturalist* 19: 174–183.

MARYAN, B., BROWNE-COOPER, R. and BUSH, B. 2002. Herpetofauna survey of Maralla Road bushland. *The Western Australian Naturalist* **23:** 197–205.

MAWSON, P.R. and MASSAM, M.C. 1995. The birds of a remnant of native vegetation on the eastern Swan Coastal Plain. *The Western Australian Naturalist* **20:** 37–47.

MYERS, N., MITTERMEIER, R.A., MITTERMEIER, C.G., da FONSECA, G.A.B. and KENT, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* **403:** 853–58.

RECHER, H.F. and SERVENTY, D. L. 1991. Long term changes in the relative abundances of birds in Kings Park, Perth, Western Australia. *Conservation Biology* **5:** 90–102.

ROSSBACH, M.H. and MAJER, J. D. 1983. A preliminary survey of the ant fauna of the Darling Plateau and Swan Coastal Plain near Perth, Western Australia. *Journal of the Royal Society of Western Australia* **66:** 85–90.

SEDDON, G. 1972. *Sense of Place.* University of Western Australia Press, Perth.

SEMENIUK, C.A. 1988. Consanguineous wetlands and their distribution in the Darling System, Southwestern Australia. *Journal of the Royal Society of Western Australia* **70:** 69–87.

SEMENIUK, V. and GLASSFORD, D.K. 1989. Bassendean and Spearwood dunes: their geomorphology, stratigraphy and soils as a basis for habitats of *Banksia* woodlands. *Journal of the Royal Society of Western Australia* **71:** 87–88.

STORR, G.M. and JOHNSTONE, R.E. 1988. Birds of the Swan Coastal Plain and adjacent seas and islands. *Records of the Western Australian Museum Supplement* No. 28: 1–75.

TURPIN, M.C. 1990. Ecological appraisal of an isolated Banksia woodland Reserve No. 3694 south of the Swan River, Perth. *The Western Australian Naturalist* **18:** 131–138.

TURPIN, M. 1991. Notes on the fauna of a remnant bushland in Victoria Park. *The Western Australian Naturalist* **18:** 233–234.

WILSON, E.O. 1987. The little things that run the world (the importance and conservation of invertebrates). *Conservation Biology* **1:** 344–346.

APPENDIX 1

Vertebrate fauna recorded at Cocos Reserve bushland remnant.
* denotes introduced species. Ground fauna: l = large pit-fall, s = small pit-fall, e = Elliott trap, o = observation. Birds: r = resident, v = local visitor, s = seasonal visitor, B = breeding, percent of visits recorded in brackets.

Amphibians			
Heleioporus eyrei	l		
Reptiles			
Cryptoblepharus buchananii	lso		
Ctenotus fallens	o		
Lerista elegans	l		
Lerista lineata	ls		
Menetia 'greyii'	lo		
Birds			
*Laughing Turtle-Dove *Streptopelia senegalensis*		v	(25%)
Rainbow Bee-eater *Merops ornatus*		s(r)	(50%)
Splendid Fairy-wren *Malurus splendens*		v?	(8%)
Western Gerygone *Gerygone fusca*		r	(100%)
Yellow-rumped Thornbill *Acanthiza chrysorrhoa*		r	(100%)
Red Wattlebird *Anthochaera carunculata*		v	(25%)
Singing Honeyeater *Lichenostomus virescens*		rv	(58%)
Brown Honeyeater *Lichmera indistincta*		rv	(92%)
Rufous Whistler *Pachycephala rufiventris* (male)		r	(42%)
Willie Wagtail *Rhipidura leucophrys*		v	(8%)
Grey Fantail *Rhipidura fuliginosa*		rB	(92%)
Black-faced Cuckoo-shrike *Coracina novaehollandiae*		v	(8%)
Australian Raven *Corvus coronoides*		v	(67%)
Silvereye *Zosterops lateralis*		v	(58%)
Mammals			
*House Mouse *Mus musculus*	e		
*Rabbit *Oryctolagus cuniculus*	o		

APPENDIX 2

Vascular plants recorded at Cocos Reserve bushland remnant. The list excludes plantings (8 species). Plants are listed alphabetically within life-form groupings.

Trees

Allocasuarina fraseriana
Banksia attenuata
Banksia ilicifolia
Banksia menziesii
Eucalyptus marginata
Eucalyptus gomphocephala

Shrubs

Acacia cochlearis
Acacia rostellifera
Acacia sp.
Astroloma sp.
Bossiaea eriocarpa
Daviesia divaricata
Daviesia nudiflora ?subsp.
Gompholobium capitatum
Hakea prostrata
Hibbertia huegelii
Hibbertia hypericoides
Hibbertia racemosa
Hypocalymma robustum
Leucopogon sp.
Petrophile linearis
Petrophile macrostachya
Xanthorrhoea preissii

Herbs and Forbs

Burchardia umbellata
Carpobrotus sp.
Cassytha sp.
Conostylis aculeata
Crassula sp. 1
Crassula sp. 2
Dasypogon bromeliifolius
Dianella revoluta var. *divaricata*
Drosera ?glanduligera
Laxmannia squarrosa
Lomandra sp. 1
Lomandra sp. 2
?Microtis sp.
Patersonia occidentalis
Phlebocarya ciliata
Ptilotus drummondii
Scaevola canescens
Scaevola repens
Thysanotus manglesianus/patersonii complex
Thysanotus sparteus

Climbers

Hardenbergia comptoniana
Kennedia prostrata

Rushes and Sedges

Desmocladus flexuosa
Lepidosperma longitudinale
Mesomelaena sp.
Schoenus curvifolius
Schoenus grandiflorus

Introduced Flora

Anagallis arvensis var. *caerulea*
Arctotheca calendula
Brassicaceae sp.
Briza maxima
Briza minor
Ehrharta calycina
Euphorbia peplus
Euphorbiaceae sp.
Gladiolus caryophyllaceus
Hypochaeris glabra
Pelargonium capitatum
Poaceae sp.
Romulea rosea
Solanum nigrum
Ursinia anthemoides
Wahlenbergia capensis